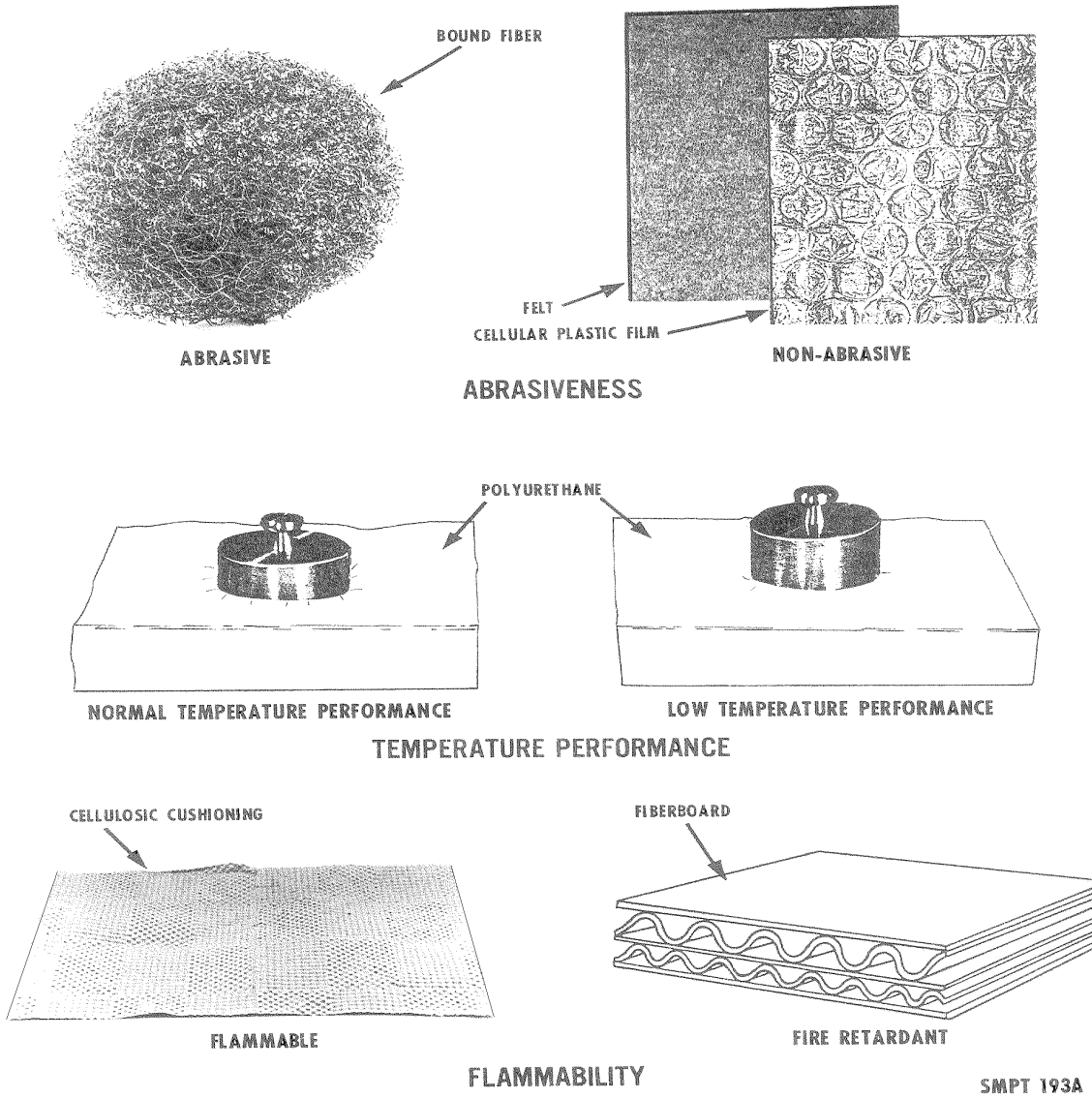

Figure 1-27. Characteristics of cushioning abrasiveness, temperature performance and flammability.

Cellulosic Cushioning Material (A-A-1898)

This material may be made of any kind of cellulosic matter which will result in a product meeting specification requirements. The cellulosic matter used may be cotton, bonded fibers, natural fibers, or creped wadding. The material is furnished in two types--Type I, water absorbent, and Type II, water resistant. It is available in three classes-Class A, low tensile strength, Class B, high tensile strength, and Class C, very high tensile strength. Cellulosic cushioning material is readily moldable and fairly resilient. Its compression set is high, its damping ability excellent, but dusting is great enough to require an excluding wrap around items susceptible to dust damage. Its performance in cold temperature is good. This material is intended for use in packaging lightweight, fragile items; as a protection against abrasion; and Type I, specifically, for absorbing liquids from containers broken in transit.

Solid And Corrugated Fiberboard (ASTM D 4727)

Both solid and corrugated fiberboard are used in cushioning, but corrugated is more frequently used because it has greater cushioning value. The most common forms of fiberboard applications are die-cuts, open end cells trays, pleated pads, and flat pads (fig 1-28). Generally, cells and trays should be held in shape with tape. Those surfaces of the cell or tray which are perpendicular to the contacting surface of the item are called bracing supports and are load bearing members. To utilize all of the strength of these bracing supports, they should bear directly on the item. Pleated pads have greater resistance to breakdown than open end cells because the load is spread over a large area rather than bracing supports. Therefore, they should be used to cushion heavier loads (up to 2 pounds per square inch). Flat pads are used to block shallow projections, to level off projecting screw heads, and to separate items within a container. They can be slotted to form partitions, or may be die-cut or punched to fit articles or irregular shape. Application of fiberboard cells, trays, and pads is illustrated in figure 1-29.

Unicellular Polypropylene Foam (PPP-C-1797)

This material is a low density, resilient, unicellular (closed cell) polypropylene foam material for use in cushioning and packing applications in the form of rolls or flat sheets. Type I electrostatic discharge is required. It is useful throughout a temperature range from minus 65°F to 160°F. It is intended for use as a cushioning wrap for low density items. The foam can be laminated to a wide range of products including paper, paperboard, and may be used for the protection for optical lenses, equipment with critical surfaces, electrical and electronic equipment, glassware, ceramics, and magnetic tape rolls. When stored in closed containers it produces no trapped volatiles which could cause fire or explosions. Polypropylene, by its nature, is unaffected by most exposures to grease water and most acids, bases and solvents. It contains no plasticizers, solvents, or lubricants.

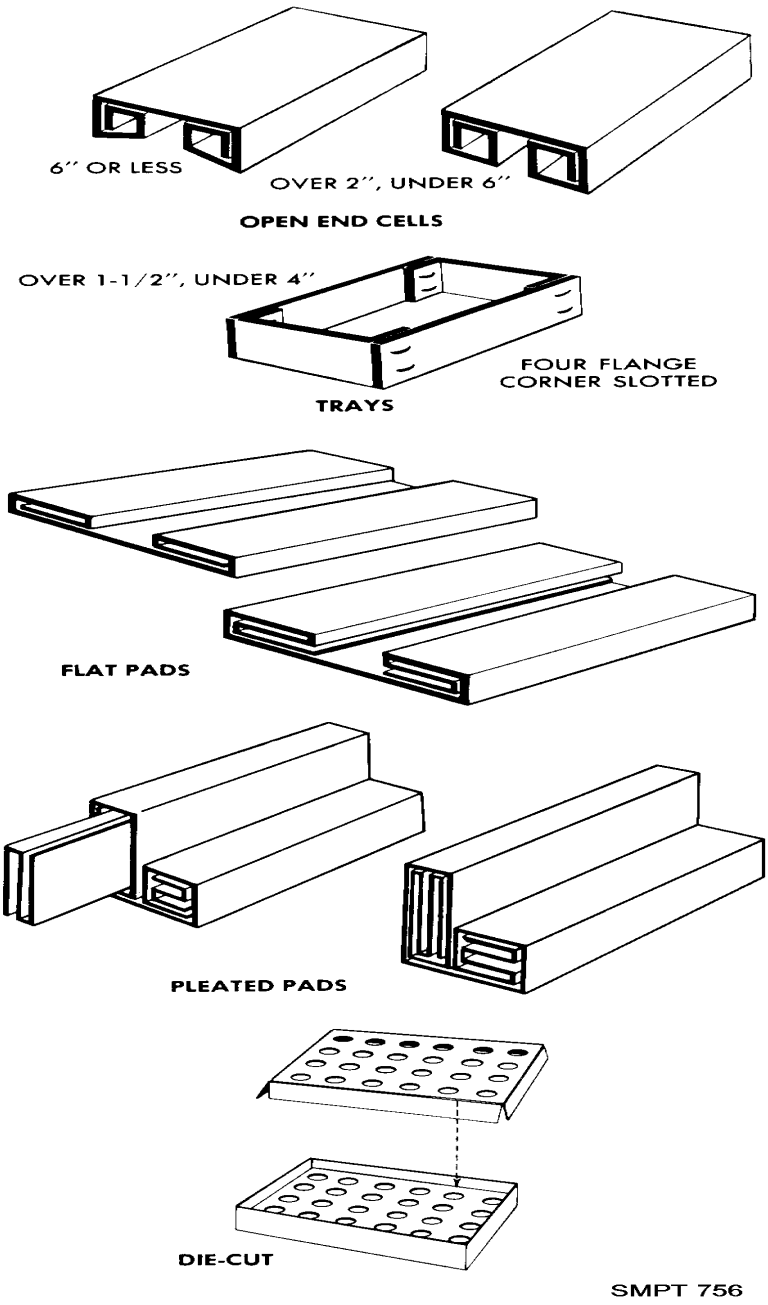

Figure 1-28. Examples of fiberboard trays, opened end cells, pads, and die-cuts

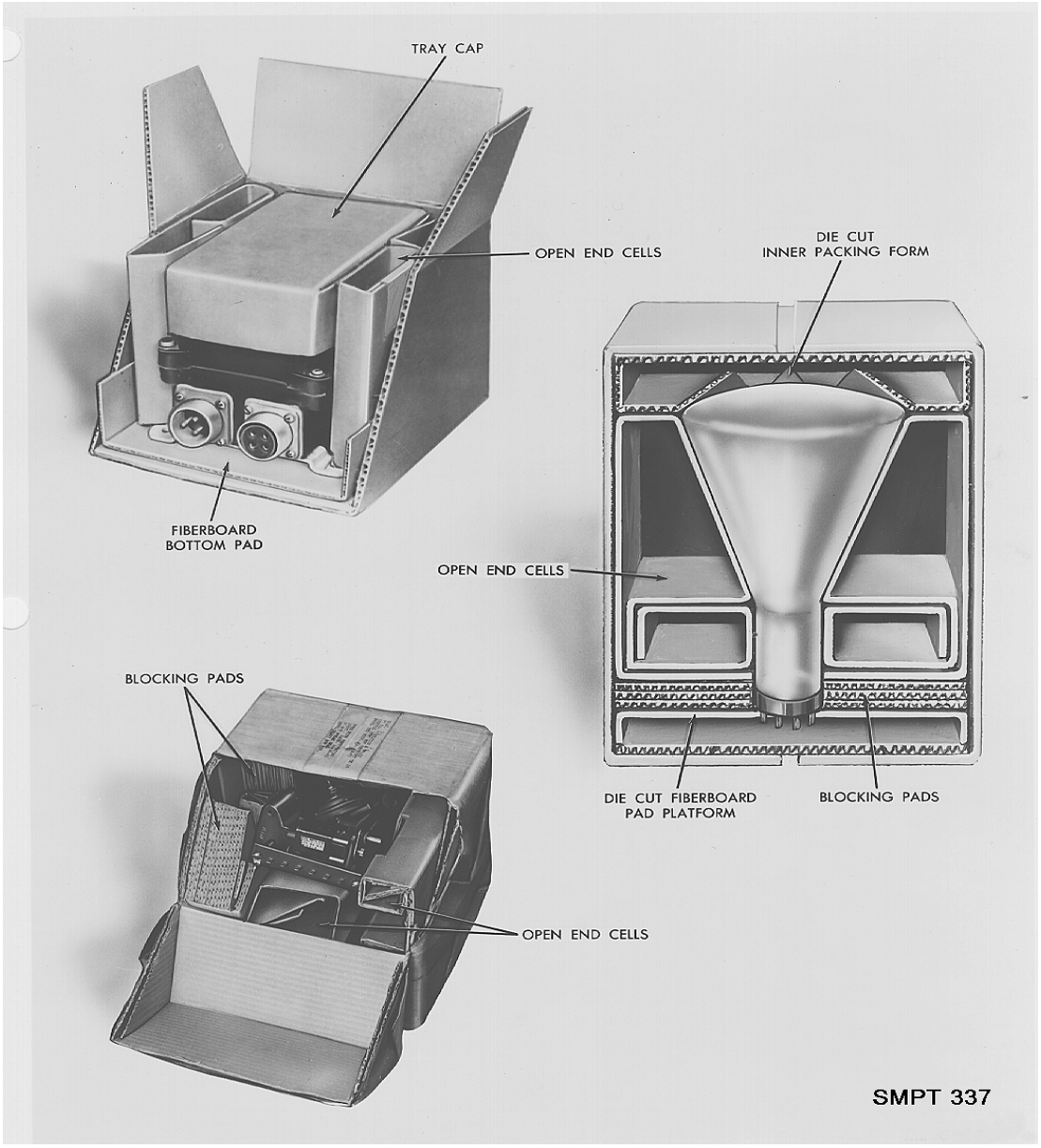

Figure 1-29. Application of fiberboard die-cuts, open end cells, trays, and pads.

EXPANDED POLYSTYRENE (PPP-C-850)

This resilient cushioning material consists of expanded polymers or copolymers of styrene for use in packaging applications. It is furnished in two types. Type I is in sheet form and Type II is in roll form. Both types come in four classes and two grades. Class 1 is soft, class 2-medium, class 3-firm, class 4-extra firm. Grade SE is self-extinguishing. This cushioning material is used within packages to protect items from damage due to shock, vibration, abrasion, and concentrated forces during handling and shipment. It is especially suited where a high degree of energy absorption is required in a minimum space and with a minimum weight of cushioning. It can also be used to provide temperature insulation or when cushioning material must perform at extremely low temperature.

CUSHIONING, WRAPPING PAPERBOARD (A-A-1051)

This is a paperboard composed of a corrugated sheet or a solid molded pulp sheet firmly cemented to a backing flat sheet of unbleached sulfate fiber paper. The paperboard is furnished in two types--light and heavy-duty, and in two styles. Style 1 material must have a backing sheet. The backing sheet is optional for Style 2. It is furnished in sheets or rolls, as desired. Both styles are flexible in all directions. This material has high compression, low resilience, excellent damping, and some dusting. The moisture content and moisture absorption are high. The moisture is not neutral and hence has a high corrosion effect. Its performance in cold weather is poor, and it is neither fungus nor flame resistant. Critical metal items must first be wrapped in a chemically neutral or greaseproof barrier.

RIGID OR FLEXIBLE POLYURETHANE FOAM (MIL-PRF-26514)

This material consists of both rigid and elastic types of foamed products obtained through the proper blending of complex synthetic chemical compounds. By proper combinations, reaction mixtures can be poured or pumped into various shaped cavities. Volatilization of the blowing agent causes rapidly stiffening resin to expand, completely filling the space. The material then sets rapidly to a lightweight, cellular structure that has excellent cushioning properties. The material is furnished in a form suitable for foaming in-place application or it may be performed and supplied in rolls, sheets, or molded shapes. Strong rigid foams, tough elastic foams, soft flexible foams, and spongy water absorbent foams can be obtained by the different choices of ingredients. Foams with densities as low as .5 pounds per cubic foot may be obtained. These foams can be adjusted to give a high or low compression set, excellent or poor damping, and high or low resilience. In other words, the material can be tailor made to meet the requirement of any type of cushioning required. There is no dusting problem; moisture content is negligible. The material is flame and fungus-resistant, and it performs well in cold climates. For further details regarding procedures and equipment used with polyurethane foam, see MIL-HDBK-775 and MIL-F-87075 respectively.

LATEX FOAM SPONGE RUBBERS

These materials are made by incorporating into the rubber an inflating agent such as baking soda, that gives off a gas which expands the mass during the vulcanization process. The rubber is made from slab rubber into sheets, strips, molded or special shapes. These materials may be supplied in cored or uncored types; soft, medium, firm, and extra firm, classes; and in flame resistant and nonflame-resistant grades. The materials have a very high resilience, low compression set, fair damping properties, high moisture content, and high moisture absorption. They produce some dusting. If kept dry, the corrosive effects are slight. Their low temperature performance is poor. The materials have a high density and are expensive to use. The molded forms are often used in conjunction with reusable containers and the initial cost is reduced by the amount of reuse obtained.

PLASTIC FILM, HEAT SEALABLE, FLEXIBLE, CELLULAR (PPP-C-795)

This material is constructed of a composite of two or more sheets of plastic film, one face having uniformly distributed closed cells (bubbles), the other a flat surface. It is available in three classes: class 1-regular; class 2-antistatic, tinted; and class 3-fire retardant. All are used as cushioning for packaging applications. Material is furnished with various cell sizes (air bubbles). It is intended for use within packages to protect items from damage due to shock, vibration, concentrated forces, corrosion, contamination, and abrasion during handling and

shipment and is especially suitable for use as inserts within transparent bags. The use of class 1 material, due to its transparency, permits inspection of the contents without opening the pack. The flexibility of the material permits it to be used as pads, bags, wraps, dunnage, or as a filler. Class 2 material protects sensitive electronic devices from electrostatic discharge damage. When fire-retardancy is required, class 3 material is selected.

Note: Many of the materials made under this specification are laminates of chlorinated plastic and polyethylene. Chlorinated organic materials give off vapors of hydrogen chloride which can combine with water to form highly corrosive hydrochloric acid.

UNICELLULAR POLYETHYLENE FLEXIBLE FOAM (PPP-C-1752)

This specification covers six types and four classes of cushioning material. Type refers to the density range of the material. For example, type VII has a density of .9 to 2.0 pounds per cubic foot while type V has a density range of 6.0 to 10.0 per cubic foot. The class generally describes the form the material takes and may be solid or laminated planks, sheets, cut shapes, rounds, or molded shapes. In addition, type VII, class 4, materials are antistatic. Temperature performance has a useful range of minus 65^{o} to plus 165^{o}F. Compression set is low and the materials are noncorrosive, nonabrasive, and virtually dust free.

OPEN CELL PLASTIC CUSHIONING (PPP-C-1842)

This material is made of one sheet of plastic film or a composite of two or more sheets of film, formed into a network of uniformly distributed open cells. The cells may be a hexagonal or fluted shape, depending upon whether a facing or reinforcing top film laminate is required. The hexagonal form is used when a reinforcing top laminate is applied to the open face of the cells. The fluted form is used when a facing is applied to the crowns of the formed cells. The resulting material is lightweight, transparent, flexible, and heat sealable. There are three types; Type I, hexagonal; Type II, fluted; and Type III, hexagonal, electrostatic free. The two styles describe whether or not the material has a top laminate or facing. All three types are available with or without a top laminate or facing and are furnished in rolls or sheets. The material is noncorrosive, nonabrasive, has low compression set, and performs well at low temperatures. The cushioning is intended for use within packages as inserts within transparent bags, wraps, dunnage, and filler.

METHODS OF CUSHIONING

Cushioning is generally accomplished by one of the following methods:

- Floated item. The item is floated in cushion material and placed within a unit container (fig 1-30). This is perhaps the method most commonly used for cushioning small, lightweight, fragile items against shock, vibration, and abrasion. Dryness and noncorrosiveness of cushioning materials are most important since both the item and the cushioning material will be inclosed in the unit container. Greaseproof barriers are required if the item is preserved. Cushioning materials must be secured about the item. Loose cushioning may result in either the displacement of the material when the pack is subjected to shock, its disintegration under repeated vibration, or the production of dust or loose particles which will be entrapped within the pack. Since a container may be dropped on any of its faces, edges, or corners, the cushioning material must be designed to withstand the full impact of the entire weight of the item in any direction.

- Floated Pack. The item is packed in an interior container which in turn is floated in cushioning materials (fig 1-30). This method is generally used in connection with semifragile items of medium size and weight. The item is initially packed (which may include cushioning or blocking) in an interior container, then floated in cushioning and placed into an exterior container. In this method, the noncorrosiveness and moisture content of the cushioning materials are not critical since the materials will not come in contact with the item. The use of absorbent cushioning materials, when used in this method, should be governed as follows:

When both the interior and exterior containers are water-resistant, the cushioning material may be simply placed between the two containers. When either container is nonwater-resistant, the cushioning material must be placed in the form of packs wrapped in a water resistant barrier material. An alternative for the second case is to provide the interior container with a sealed water-resistant wrap and the exterior container with a sealed liner. The cushioning material is then placed between the two barriers.

SHOCK MOUNTS

The item is cushioned by means of shock mounts. This method is used to cushion fragile items and sensitive instruments or mechanisms that can be damaged by shock and vibration. The weight and size of the item may vary from light and small to heavy and large. The shock mounts may consist of elastomeric springs or rubber blocks. This method of cushioning may be accomplished in four main ways.

The item may be suspended directly by means of elastomeric springs. The item may be blocked in a cradle and the cradle suspended by means of elastomeric springs. The item may be boxed in an intermediate container and the intermediate container suspended by means of elastomeric springs. The item may be boxed in an intermediate container and the intermediate suspended by means of rubber shock mounts.

PACKING PROBLEMS

The basic reason for packing any item is to provide enough protection against the hazards it is likely to encounter during shipment. This minimizes the chances that damage will occur during the interval between the time the pack leaves the shipper and when the item is placed in use by the receiving activity. It is, of course, an impossibility to evaluate all the hazards that might be encountered in transit, as there are too many variables which can affect the condition in which an item may be found upon arrival at its destination. The guidelines to packing presented herein have indicated the principles and practices that have been found satisfactory in giving protection under average handling and storage conditions. If the solution of a specific packing problem is not located in this section, the following procedures are recommended for shipment from depots:

DOMESTIC SHIPMENTS

If an item is being shipped domestically, pack the item in a manner which closely duplicates the pack in which the item was received.

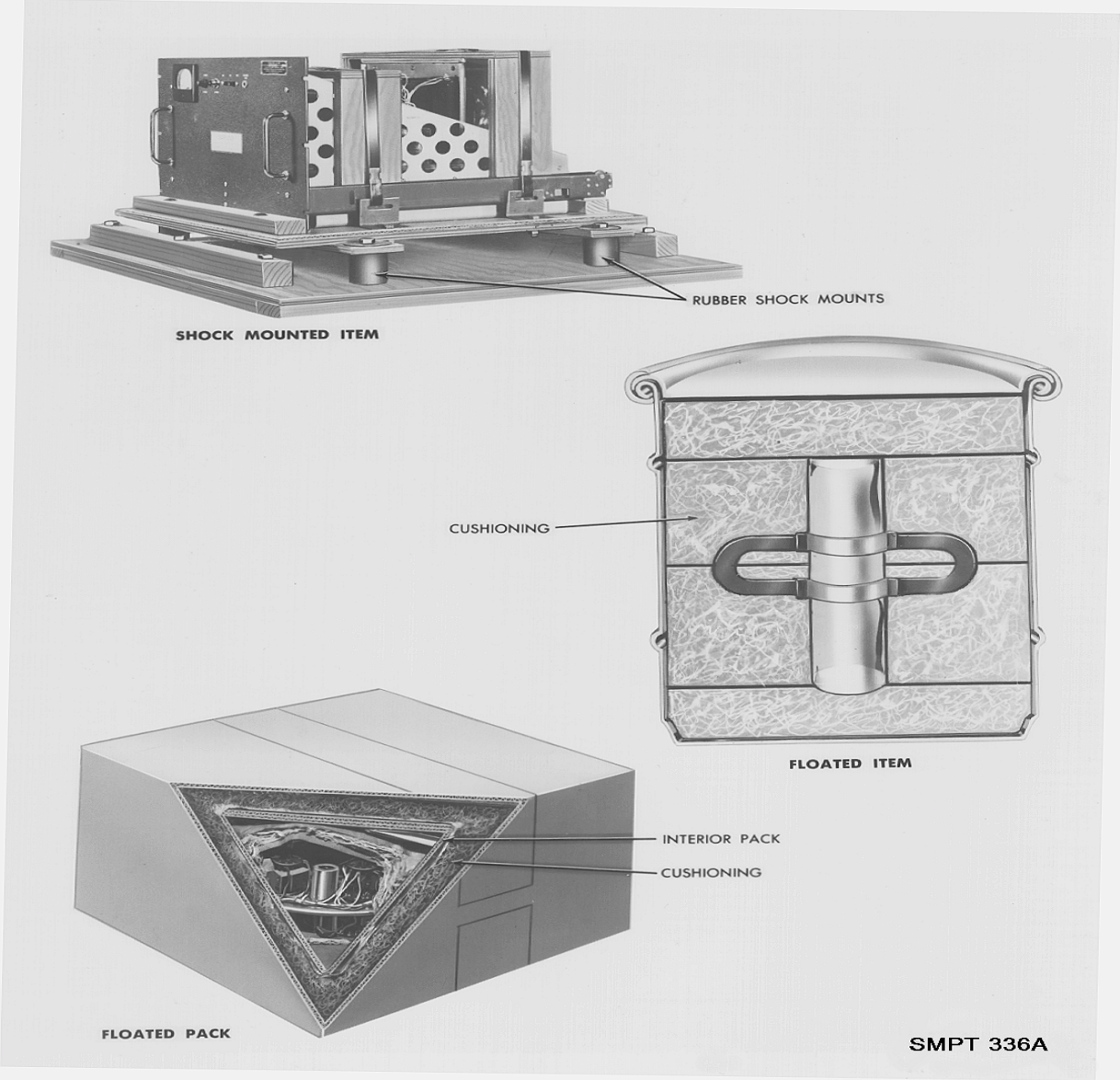

Figure 1-30. Methods of cushioning.

OVERSEA SHIPMENTS

If shipment overseas is involved, and no previous history of a container in which the item had been shipped to a similar destination is available, construct a pack embodying as many as possible of the principles outlined in this section. This pack should be prepared exactly as it would be shipped including complete preservation and interior packing. It is then tested by subjecting it to the applicable performance tests. The tests are based upon the size as well as the gross weight of the container since both influence the amount of rough handling the container will receive. Small, light packages are easier to move than the larger and heavier packs, and consequently, they can be expected to receive a greater amount of handling. Performance tests are required for the primary purpose of determining the adequacy of all the operations entering into preparation of a pack. At the conclusion of the tests, performance is based on the condition of the container, its contents, the blocking and bracing, cushioning, preservation, and other packing materials. The pack should be examined for any

damage, noting in particular any obviously weak points which might need to be strengthened. Usually the container, if constructed according to specifications, will withstand the rough handling. If, however, the container is damaged, a study should be made of the causes. Deficiencies in the blocking and bracing may result in damage to the container, in which case these deficiencies should be corrected. Other times the nature or shape of the item may cause the container to fail. Then, the container should be reinforced. In any event, when deficiencies become obvious, either in the containers, the contents, the blocking and bracing, cushioning, preservation, etc. the pack should be appropriately modified and the test repeated until no damage occurs which affects the utility of the pack.

PACKING SMALL, LIGHTWEIGHT ITEMS

As previously pointed out, cushioning materials are frequently employed to block lightweight items. In some instances, however, cushioning materials such as fiberboard, are primarily used for blocking. The effectiveness of fiberboard as blocking and bracing depends upon its strength and its resistance to moisture when not protected by suitable moisture barriers. The domestic class of fiberboards will rapidly absorb moisture with a resulting loss of strength. The weather-resistant class on the other hand, retains a greater proportion of its strength in the presence of moisture. Fiberboard is most frequently employed as blocking in fiberboard containers because the items packed in them are usually small and lightweight and do not require heavier types of blocking. Also, the container manufacturer can provide and fabricate pads, cells, trays, or partitions of the same material a low cost.

Both solid and corrugated fiberboard are employed as blocking material, but the corrugated is used more frequently because it has a greater cushioning value and because of its lower cost. Occasionally, a pack will contain a comparatively large void which will necessitate blocking to prevent shifting of the item, In such cases, a fiberboard carton may be used for blocking the item in place. The carton used for blocking should be closed and sealed, and must be strong enough to provide adequate strength in all directions.

PACKING LARGE ITEMS

Large items require special attention to adequately secure them within the container. Such items are anchored to the base of the container and blocked and braced into a secured position on the base. A clearance of a least 1 inch is provided between the end, side, and top panels and the item is seldom blocked and braced to these panels. Thus, the container must have a rigid base and the rest of it be must free to distort without placing stresses directly on the contents.

ANCHORING TO BASE OF CONTAINERS

Crates for large and heavy items should have sturdy bases to which the items can be adequately secured. Many ingenious methods have been developed to hold items to crate bases. For sill and skid type crates, it is essential that the load be carried primarily by the outside skids or sills. This means that loads that cannot be secured to the side sills or bases must be provided with load bearing members that transmit the load to them.

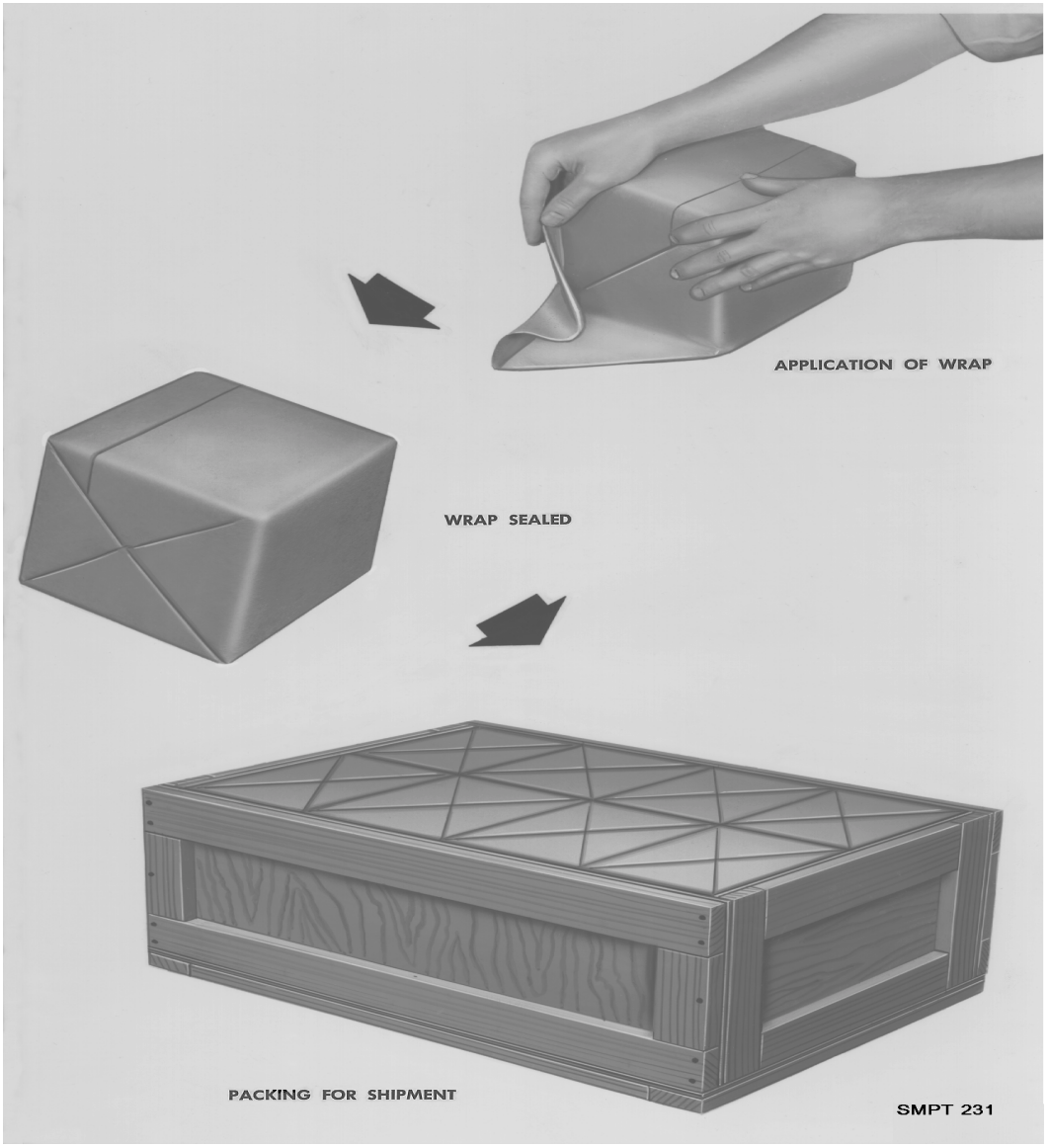

Figure 1-31. Waterproofing of individual packages.

BLOCKING AND BRACING A LARGE ITEM

After the item has been anchored to the base of the container to prevent its movement in a vertical direction, it is blocked and braced to prevent its movement in a horizontal direction. An item should be anchored only to the base, hence all bracing and blocking should be so secured.

CLEARANCE BETWEEN ITEM AND CONTAINER

When an item is blocked, braced, anchored, or tied down to the inside of one face of a container or to an auxiliary base which, in turn, is so secured, a clearance of not less than 1 inch should be provided between the item and all members of the faces of the container. A minimum clearance of 2 inches should be provided around fragile parts of the item that might be damaged due to slight distortion of the container. A minimum 2 inch clearance should be provided between items within floating bag barriers and adjacent members of the container.

WEATHERPROOFING THE PACK

At this point in the sequence of packing operations, it is assumed that a careful study has been made of the item to be packed; a suitable container has been selected; blocking, bracing, and cushioning have been designed; and the contents are ready to be placed into the container. The next step is to provide, when necessary, a protective barrier in the form of a case liner, crate liner, shroud, wrap, or tarpaulin fabricated from one of several materials. The barriers are intended to prevent deterioration of the item, and the preservation and packing materials used to protect it, by excluding the entry of water, by limiting the entrance of water vapor, or by diverting water from the materials which are subject to water damage. In addition, barriers will afford protection from dust, dirt, and other foreign matter. Barriers designed to prevent the entry of water (waterproof barriers) will not be used when the interior packs have been individually waterproofed as shown in figure 1-31, nor when the asphaltum in the barrier material or sealants may prove injurious to the inclosed items. The water-vaporproof protection afforded by caseliners differs from that afforded by a Method 50 package in that water absorbing desiccant is not used with caseliners.

WEATHERPROOFING (CASE LINERS, WRAPS, AND SHROUDS)

Except as provided herein, weatherproof liners, wraps, shrouds or other suitable means shall be provided in shipping containers as necessary to shield the contents from the effects of water, water vapor, dust, dirt, and other harmful matter. When a completely inclosed barrier is provided as in the case of liners and wraps, all seams should be completely and continuously sealed to offer protection equal to the barrier material itself. Barrier materials and sealants constructed with asphaltum shall not be used in the presence of mothproofing chemicals such as paradichlorobenzene and naphthalene. Barrier materials and sealants constructed of asphaltum shall not be used to protect items subject to stain or other damage caused by asphalt unless such items are initially protected to exclude asphalt.

TYPES OF WEATHERPROOFING BARRIERS

The particular type of barrier to be used depends on the type of exterior container or the intended use of the barrier (table 1-8). In selecting the type of barrier to be used, consideration should be given to the following:

- Sealed case liners and sealed wraps are used to resist the passage of water and water-vapor. Fabrication of case liners is covered below.
- Sealed case liners will not be used in the packing of material unless specifically authorized.
- Crate liners and shrouds are used to shed water from the top and sides of the item, allowing free circulation of air. Shrouds are fabricated from waterproof barrier material conforming to PPP-B-1055, Class E or heavier. The seams are sealed with water-resistant adhesive conforming to MMM-A-260. Shrouds also may be made of material conforming to L-P-378.

It is important that shrouds be secured to prevent damage or loosening by storms. They should be weighted if necessary and arranged to avoid formation of water pockets. Shrouds should never extend entirely to the base of a crate or to the ground since the free circulation of air around the enclosed equipment is thereby prevented.

Table 1-8. Application of weatherproofing barrier materials for packing

Use	Barrier Materials				
	L-P-378	PPP-B-1055	MIL-B-121	MIL-B-131	MIL-B-22191
Case Liner	.....	Classes H-2, H-3(a), H-4, H-5, L-2(b), and M-1 Waterproof	Types I and II, Grade A, Class 1 Waterproof	Classes 1 and 2 Watervaporproof	
Sealed Wraps and Plastic Bags	Type I Water-proof	Classes B-1, B-2, B-3, C-1, C-2, C-2(a), E-1, and E-2 Waterproof	.....	Classes 1, 2, and 3 Watervaporproof	Types II or III Waterproof
Crate Liner	.....	Classes C-2(a), E-1, E-2, E-2, H-5, L-2(b), and M-1 Watershed			
Shroud	Types I and II Watershed	Classes E-2, H-5, and M-1 Watershed			
Baling	.....	Classes B-1, B-2, B-3, and E-2 Watershed			
Temporary Tarpaulin	Type I Watershed	Class L-4 Water-shed Class P-1			

CASE LINERS, OVERWRAPS, AND PLASTIC BAGS

Flexible waterproof or watervaporproof case liners, overwrap sheets, and plastic bag liners should be fabricated and closed in accordance with MIL-L-10547.

They shall be furnished in the following types: Type I, high-top case liner (fig 1-32); Type II, double-top pad liner (fig 1-33); Type III, overwrap sheet, and Type IV, plastic bag. Type II liners may be used when a level, rigid surface exists or when the depth of the case liner exceeds 36 inches. Type III overwrap sheets are barriers used around intermediate boxes. Type IV plastic bag liners are used in the same manner as Type I and II case liners.

They are available also in six grades as follows: Grade A, watervaporproof; Grade B, waterproof, all temperatures; Grade C, waterproof, asphalt laminated kraft; Grade D, waterproof and greaseproof; Grade E, waterproof, greaseproof, transparent, all temperatures, and Grade F, waterproof, transparent, all temperatures.

Table 1-9 shows the barrier material to use depending on the type and grade of case liner, overwrap, or bag liner required and whether they are to be used for subsistence or nonsubsistence items.

Case liners should be made large enough so that the weight of the load will be borne entirely by the container, not by the liner. There should be no tension in the walls or joints of the liner after it has been closed around the contents.

Experience has shown that under some conditions, especially when the contents do not fill the case liner completely, waterproof case liners do more harm than good by trapping and holding water rather than preventing its entry. It is not essential that there be openings in the sealed liner for this to happen. If the liner material has low resistance to watervapor transfer (a common occurrence) water can enter in the form of vapor and condense on items within the liner. At the end

of an extended outdoor exposure period, sealed case liners have been opened and found partially filled with water. When packed items need protection against water, it is preferable to incorporate the protection in the individual unit packages in lieu of using case liners.

Linings for Drums, Kegs, Barrels, and Bags. Linings should be provided for drums, kegs, barrels, or bags when their contents require protection not otherwise provided by the containers against sifting, contamination, or free water. The lining material should conform to PPP-B-1055 or MIL-B-22191. Fabrication and closure seams should be heat sealed or sealed with adhesive conforming to MMM-A-260, as applicable.

WATERPROOF AND WATERVAPORPROOF WRAPS

Waterproof and watervaporproof wraps shall be fabricated and sealed in accordance with MIL-L-10547.

UNSEALED WATERPROOF WRAPS

Unsealed waterproof wraps should be applied to shed water while permitting breathing and circulation of air.

Table 1-9. Barrier materials for case liners, overwraps, and plastic bag liners

Use	Liners, overwraps, and bag liner		Specification	Barrier materials
	Grade	Types		Classification
Subsistence item	C F	I, II, III IV	PP-B-1055 L-P-378	Classes H-2 thru H-5, M-1 Type I
Nonsubsistence item	A	I, III	MIL-B-131	Classes 1, 2 and 3
	C D E	I, II, III I, II IV	PPP-B-1055 MIL-B-121 MIL-B-22191	Classes E-1, E-2, H-1 thru H-5, L-2, M-1 Types I and II, grade A, class 1 Type II

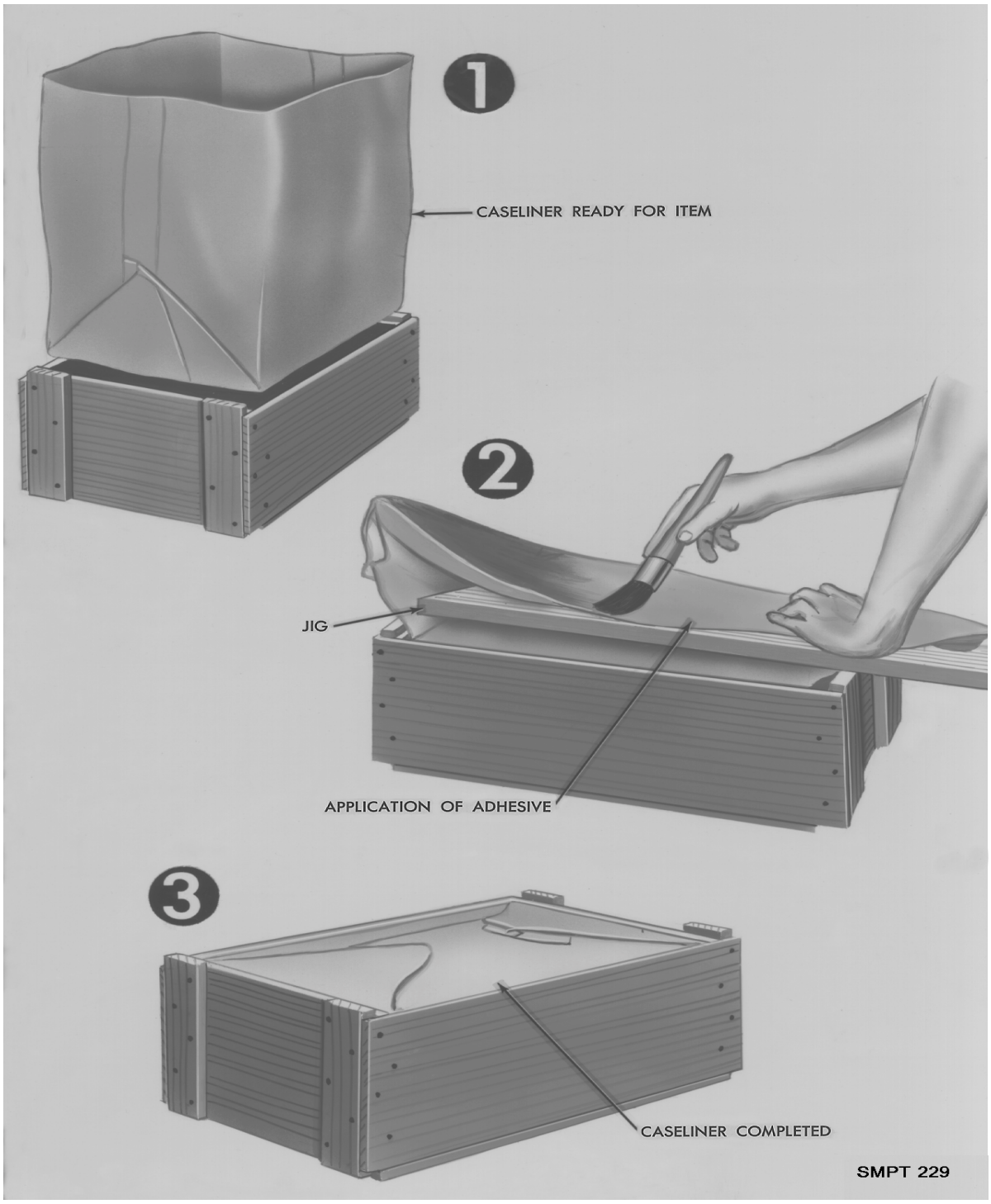

Figure 1-32. Using and closing of high top caseliner.

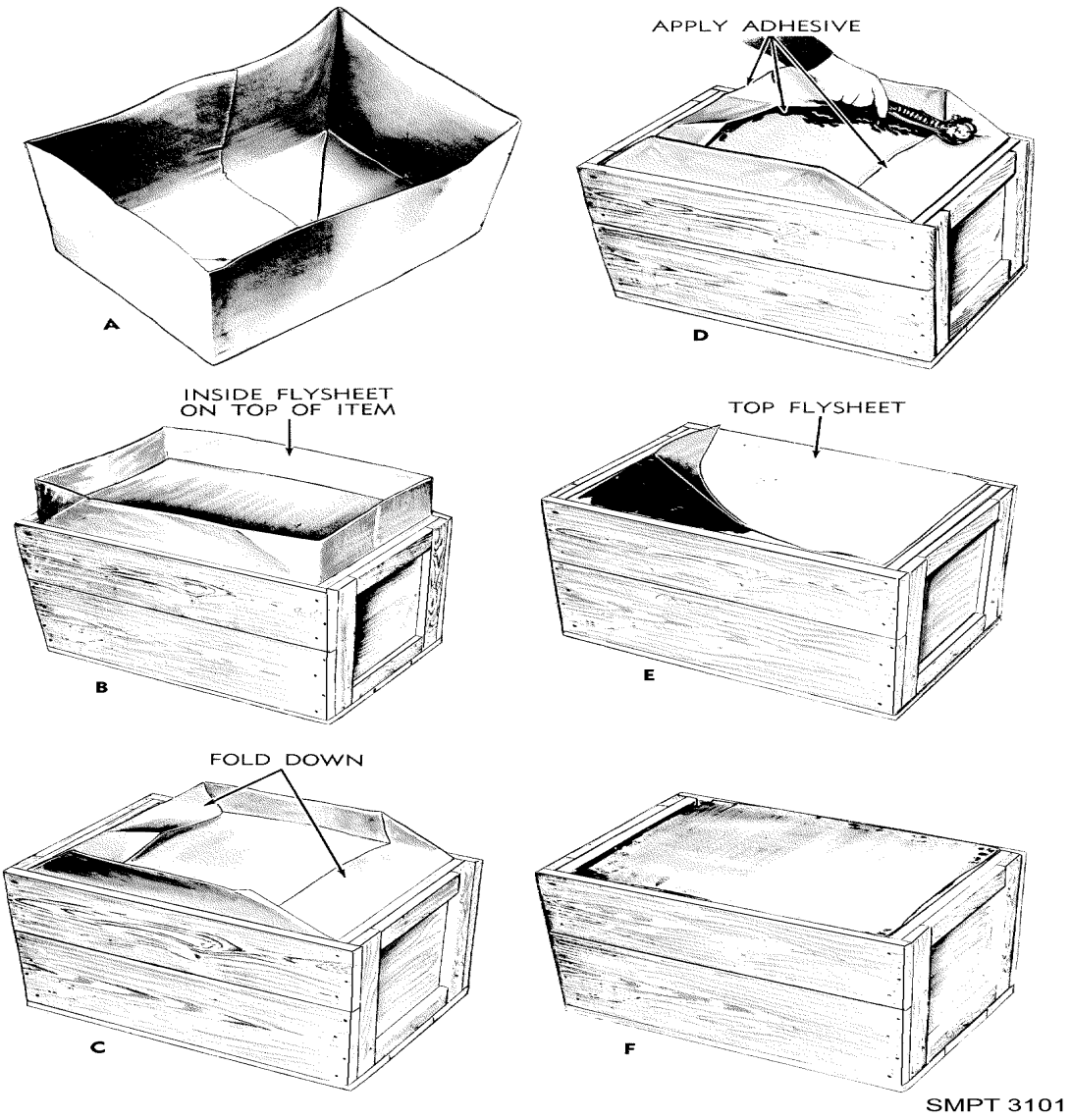

Figure 1-33. Double top pad closure caseliner.

TESTING OF PACKS

PURPOSE OF TESTING

The purpose of testing is to prove the adequacy of packaging design and the workmanship of fabrication. Testing may be performed in the research and development phase or by tests at the operational level. Since containers in the storage and shipment cycle are subjected to various and constantly changing storage and shipping hazards, it is difficult to develop complete data for their design by merely observing the containers in service. Examinations of failures will reveal the weaknesses and suggest the specific principles of design to overcome such failures. Since service tests are not performed under controlled conditions, laboratory tests are necessary to simulate field hazards. Each test is designed to reproduce one or more of the stresses encountered in the field. During the test cycles the sequence of failures can be observed, classified, and the

weaknesses from which the failures result determined. By means of such tests any number of containers can, in turn, be subjected to exactly the same actions, thus providing the data necessary to produce balanced construction and workmanship. On the following pages are described a number of methods that have been devised for subjecting containers to hazards similar to those encountered in the field. Both laboratory and field testing are necessary since there are certain conditions inherent in each method of testing that cannot be duplicated in the other.

TYPES OF TESTS

Development and testing of packs and containers should be started as soon as possible after initiation of item development. Some of the tests most commonly used in proving design adequacy include the vibration, rough handling, and cyclic exposure tests (fig 1-34). One or more of these tests are usually applicable to the design of military packs. In many cases the technical activity having design responsibility, has intervals tests and procedures that are applicable to a specific design problem. The documents most generally used for test guidance are MIL-STD-1186. ASTM D 4169, Performance Testing of Shipping Containers and Systems, and ASTM D 5276, Drop Test of Loaded Containers by Free-Fall, should be referenced.

TESTING (MIL-STD-2073-1)

After an item has been packed in accordance with one of the MIL-STD-2073-1 methods, tests are conducted to determine the effectiveness of the pack. The types of tests conducted will depend on the particular method used. The tests called for in MIL-STD-2073-1 are not all-inclusive, however, and additional or different tests are sometimes required. The types of tests specified in MIL-STD-2073-1 for proving the adequacy of unit protection are the leakage test, rough handling tests, cyclic exposure tests, and the heat-seal seam tests.

TESTING (MIL-STD-1186)

When packs prepared for shipment in accordance with the detailed requirements of MIL-STD-1186 are tested for any rough handling required, there should be no settlement or shifting of contents. Further, the testing should cause no damage to the contents and should not loosen, break, or displace the anchoring, blocking, or bracing. The testing should not render the interior containers, wraps, liners, barriers, or cushioning ineffectual in providing continued and adequate protection to the contents.

TYPES OF ROUGH HANDLING TESTS

The various types of rough handling tests include: free-fall drop test; cornerwise drop test; pendulum impact test; incline-impact test; edgewise drop test; vibration test; and others. The particular tests employed usually depend upon the size and shape of the package. Completed packages as prepared for shipment are given a rough handling test when specified. When a rough handling test is required, it precedes applicable tests specified to detect leaks and inadequate seals or closures and preservative retention.

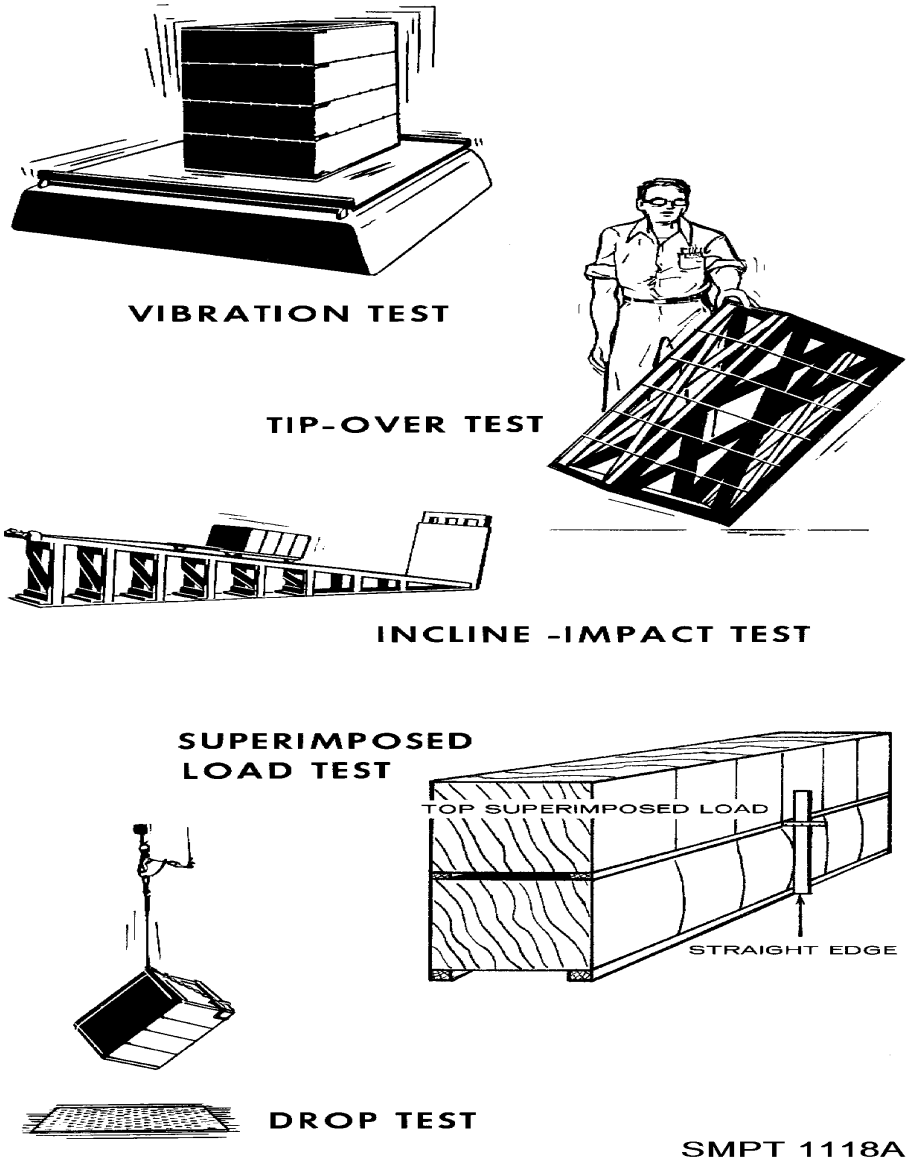

Figure 1-34. Examples of container test.

Inspection and tests for leaks in barrier materials, seals and closures, and preservative retention, when required, are performed on the contained unit pack(s) following the rough handling test to determine existence or extent of detrimental effects. Unless a particular test is specified, selection of the applicable rough handling test should be in accordance with ASTM D 5639, Selection of Corrugated Fiberboard Materials and Box Construction Based on Performance Requirements.

SMALL CONTAINERS

Only free-fall drop tests and vibration tests shall apply to small containers; both or either vibration test shall be conducted at the option of the contractor. Small containers are those having a gross weight of 110 pounds or less. Any container with skids is tested as a large container. Any container holding an item that has a net weight of more than 100 pounds and which is fastened to a base within or to the base of the container will be tested as a large container.

LARGE CONTAINERS

All rough handling tests, except for free-fall tests, shall apply to large containers; both or either vibration test shall be conducted at the option of the contractor. However, tipover tests will apply only when additionally specified. Either impact test shall be conducted at the option of the contractor. Large shipping containers are those measuring more than 60 inches on any one edge or diameter, or those which when loaded, have gross weights in excess of 150 pounds or those which have skids.

FREE-FALL DROP TEST (FIG 1-35)

The pack may be tested in accordance with ASTM D 5276. A drop tester is any suitable apparatus which will allow an absolutely free, unobstructed fall of the container at the orientation and the direction required. A lifting device that will not damage the container will be used and a level steel or cement surface to absorb all shock without displacement will be provided. The height from which the specimen should be dropped is dependent upon the weight, size, kind of container, and level of pack. This test is meant to simulate the fall of an item dropped by a person from a height they would normally use to lift and carry an item of that size.

The container should be dropped from the designated height onto a steel, concrete or stone surface of sufficient mass to absorb the shock without deflection in such a manner that the designated surface of the container absorbs the full force of the fall (fig 1-35). This test should be repeated until the designated number of drops have been made. (The height refers to the distance from the steel, concrete, or stone surface to the nearest surface of the container when suspended prior to the fall.) The fall shall be a free fall, in that no ropes or other suspending media are attached to the container during the fall. If the container is of the drum type, the top and bottom of the drum should be marked so that the circle of the top and bottom is quartered, and the test should be applied to each quartered section.

TIPOVER TEST (FIG 1-34)

The loaded container is placed on its bottom and slowly tipped until it falls freely (by its own weight) on its side to a smooth level, concrete slab or similarly unyielding surface. Structural damage to the exterior shipping container which would result in either spilling of contents or failure of the container in subsequent handling is cause for rejection. This test is meant to simulate the impacts of accidentally tipping over a container. It is intended that the tipover test be used only on containers that are susceptible to accidental tipovers.

EDGEWISE DROP TEST (FIG 1-36)

The loaded container should be supported at on end of its base on a sill or block 6 inches in height and at right angles to the skids. The opposite end of the container should be allowed to fall freely from the specified height onto a steel, concrete, or stone surface of sufficient mass to absorb the shock without deflection. The test should be applied twice to each end of the container. If the size of the container and the location of the center of gravity are such that the drop tests cannot be made from the prescribed height, the height of the sill will be increased.

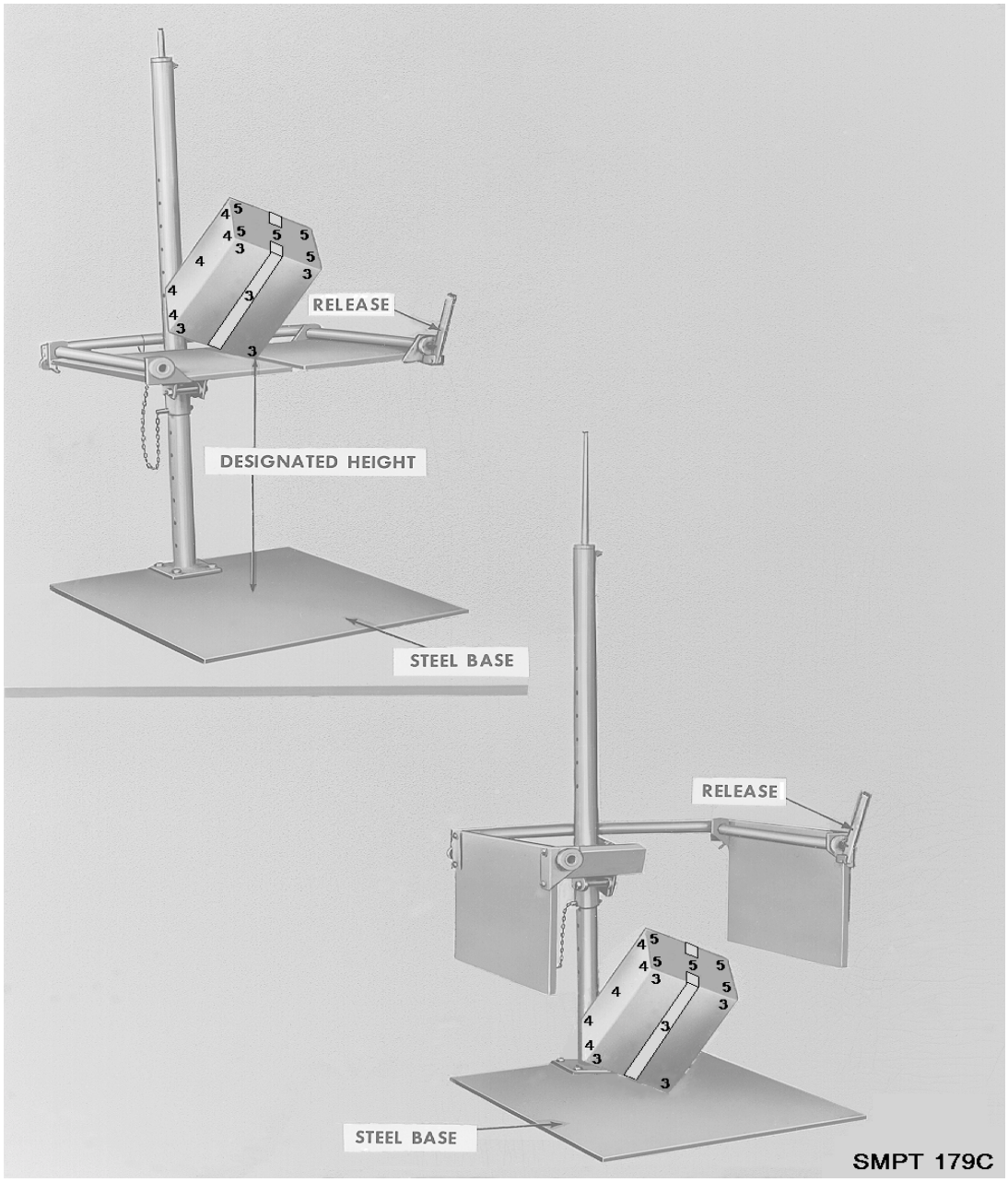

Figure 1-35. Free fall drop test.

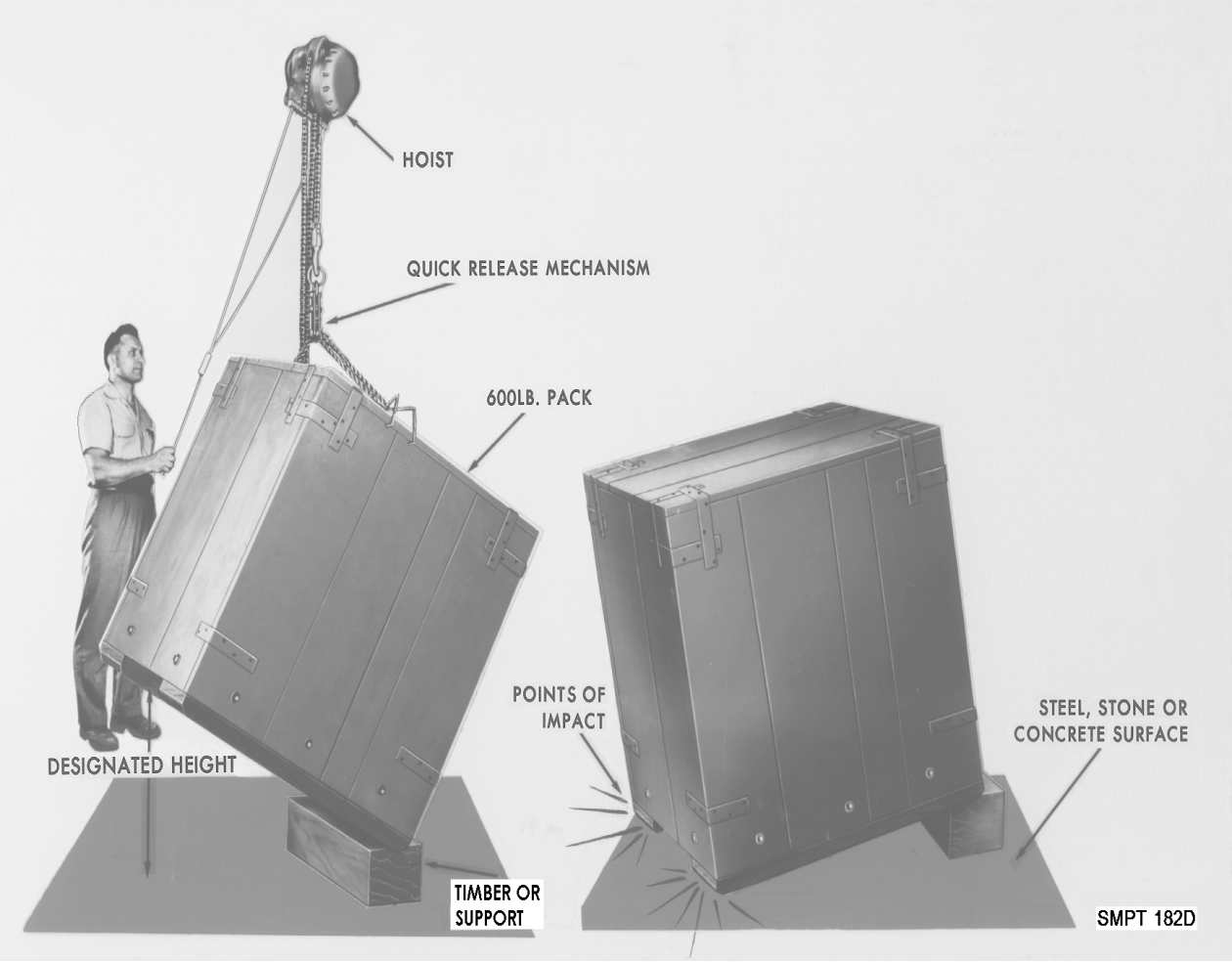

Figure 1-36. Edgewise-drop test.

CORNERWISE-DROP TEST (FIG 1-37)

The container should be supported at one corner of its base on a block 6” in height. A 12” block should be placed under the other corner of the same end of the container. The lowest point of the opposite end of the container should then be raised to the specified height for the weight and allowed to fall freely onto a steel, stone, or concert surface of sufficient mass to absorb the shock without deflection.

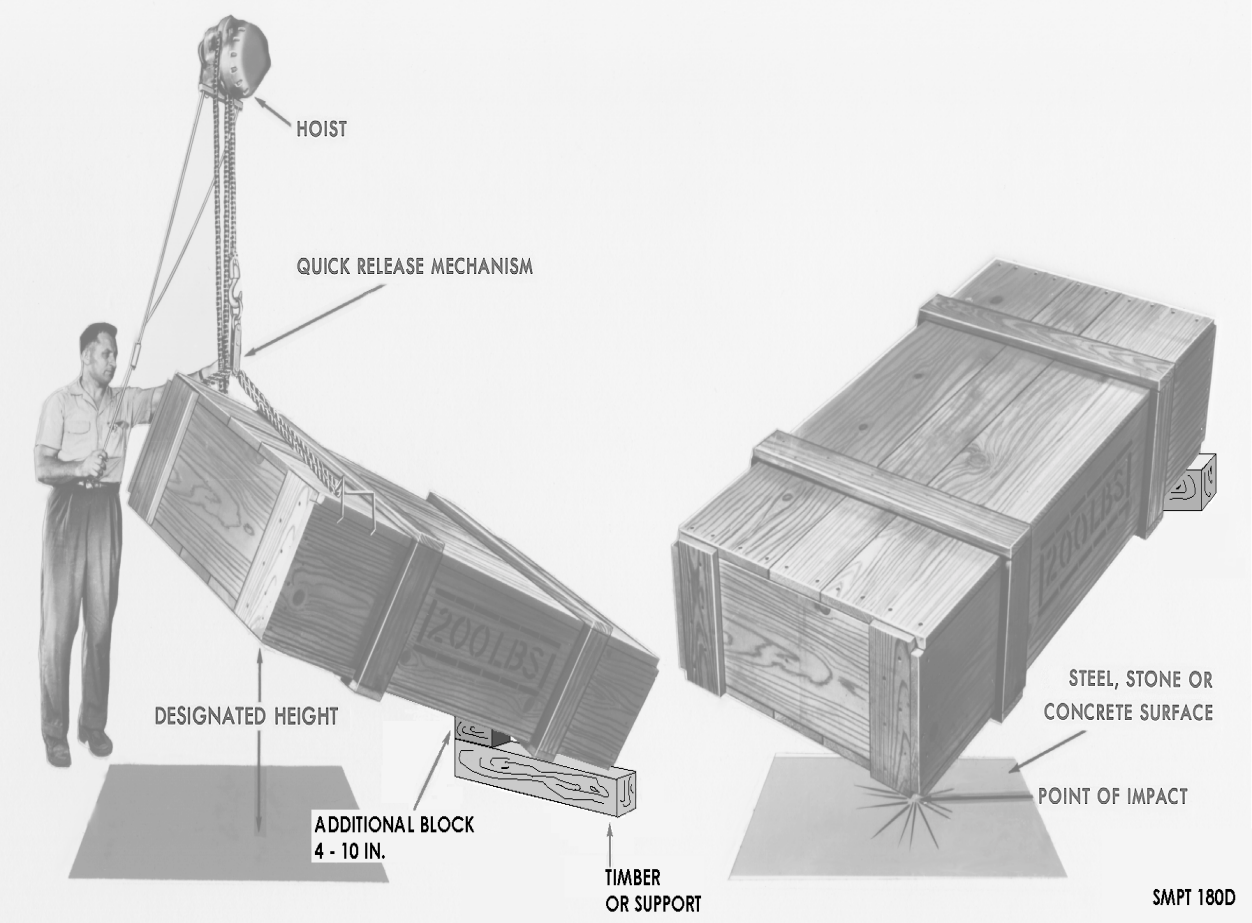

Figure 1-37. Cornerwise-drop test.

IMPACT TESTS

Packs having a gross weight exceeding 150 pounds or any dimension exceeding 60 inches, closed for shipment, may be subjected to one of the following guided impact tests. A single impact should be applied to each of two opposite ends. The tests are performed to simulate railroad jumping or other accidental impacts, evaluating the adequacy of the blocking, bracing and tie downs used to secure a load on or a in a rail car.

INCLINE-IMPACT TEST (FIG 1-34)

This test in accordance with ASTM D 5277 simulates the abuses encountered by packs in freight cars or trucks when the vehicles are subjected to the sudden starts and stops.

The pack, mounted on a movable platform dolly which rides on a plane inclined 20 degrees from the horizontal, is released from a known distance up the incline an permitted to strike against a fixed backstop at the bottom of the plane. The magnitude of impact shock is varied by using different release points.

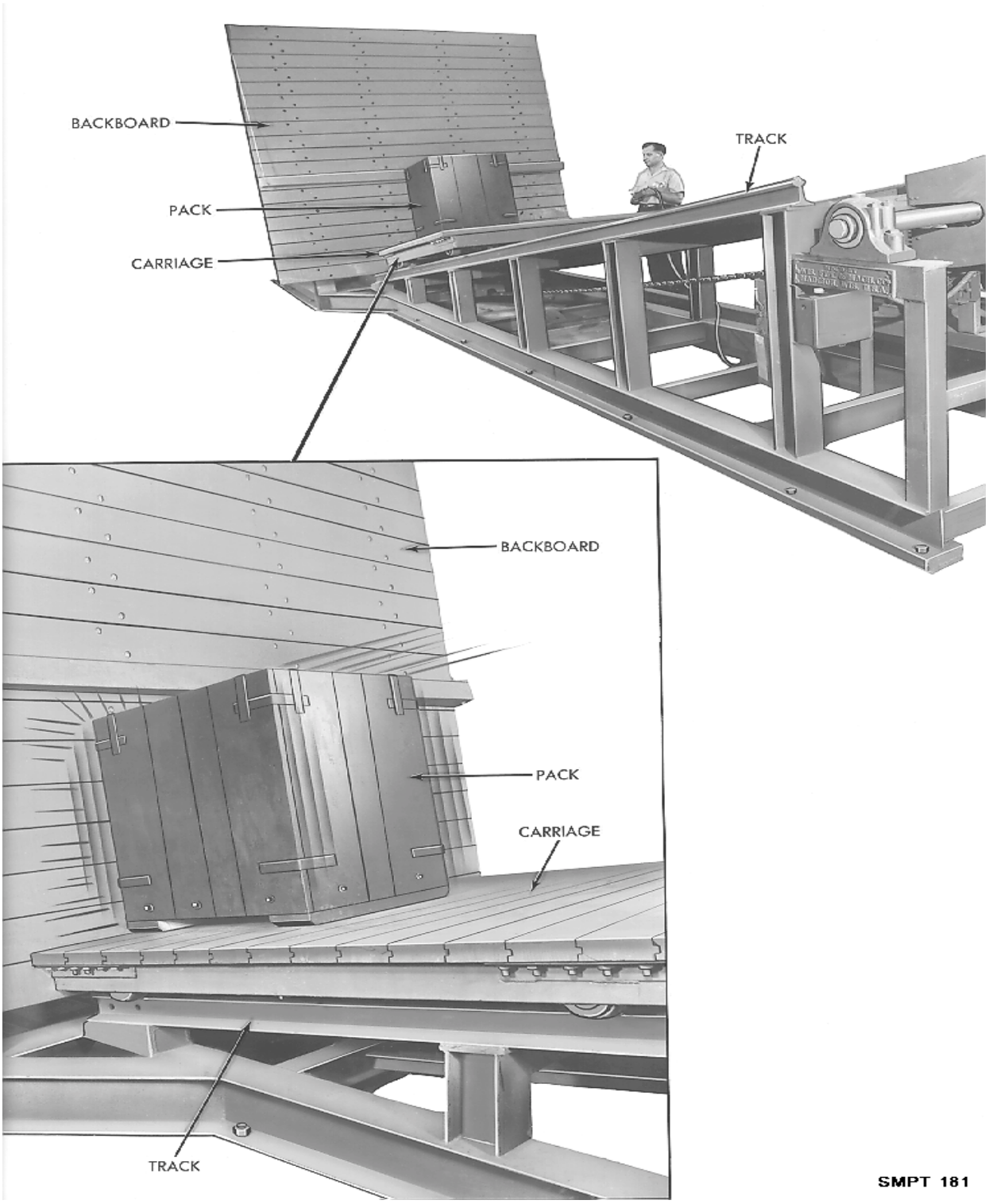

Figure 1-38. Impact test.

SUPERIMPOSED-LOAD TEST (FIG 1-34)

The procedure is applicable for determining the ability of shipping containers to resist loads such as imposed on the bottom container of a stack of similar container in storage, or on a container supporting top dunnage and superimposed lading. Test is applicable for determining the ability of shipping containers to resist loads superimposed on their tops as imposed by piling without top dunnage many small, heavy packs on a container.

Stackability, with dunnage tests, are conducted by placing a prescribed load on the top of the container in a manner simulating the effect of similar containers being stacked on top, and the load shall be allowed to remain in place for 1 hour. A check shall be made of any changes or breaks in the container, such as apparent buckling or failure of members in the sides or ends. Observations should be made to determine if the distortions are enough to damage or dislodge the interior packing or contents.

The uniformly distributed, without dunnage superimposed load test is conducted by placing weights not greater than 10 x 10 inches in outside length and width, on top of the container in a symmetrical pattern approximating uniform load and allowed to remain in place for 1 hour. Measurements of distortions shall be made immediately before the load is removed. Checks should be made of any changes or breaks in the container, such as apparent buckling of failure of members in the top, sides or ends.

VIBRATION TEST (FIG 1-34)

The forces and motions typical of railroad cars, motor trucks, and air transportation can result in vibration which frequently produces deterioration or partial crushing of unit or interior packing which reduces resistance to other shocks, such as impact from dropping, jolting, or bumping. Testing can disclose weakness in assembly of the packed item. The pack may be vibration tested in accordance with ASTM D 3580.

VIBRATION (REPETITIVE SHOCK) TEST

Test is used to indicate whether or not a package and its contents will withstand transportation shocks and vibration without damage when the shipment is not securely tied down to the floor of the vehicle. The package is placed on, but not fastened to, a platform supported on a mechanism that will maintain the surface essentially horizontal as it vibrates the platform. The amplitude of the vibration will be 1 inch total. The frequency will be variable within as approximate range from 3 to 5 Hz. Fences, barricades, or blocking can be attached to the platform to keep the package in position without unnecessarily restricting the vertical or rational movement of the package. Unless failure occurs, total time of vibration will be 2 hours if the package is tested in one position; 3 hours if tested in more than one position.

VIBRATION (SINUSOIDAL MOTION) TEST

Test in accordance with ASTM D 4169 is used to determine the adequacy of packages that contain items susceptible to damage from vibration encountered during shipping and are tied down to the floor of the carrier. The package is attached securely to a platform supported on a mechanism that will maintain the surface essentially horizontal as it vibrates the platform vertically. Controls are provided to vary the frequency form 2 to 500 Hz as specified. If the package might be shipped in more than one position, the package will be tested in each position.

SIMULATED CONTENTS

Simulated contents of the same dimensions, weight, center of gravity, and physical properties as the actual contents may be substituted in the tests described above. A shock-recording instrument of an acceptable type should be appropriately installed within the shipping containers. This provision is intended to avoid unnecessary damage or complete destruction of valuable commodities.

INTERPRETATION OF RESULTS

All materials and components shall be free from damage or evidence of displacement which affects the utility of the pack. When specified, functional tests should be conducted on the items or equipment to determine freedom from operational malfunction.

MARKING OF PACKS

Marking permits ready identification of military supplies and equipment for shipment and storage. No matter how well an item is made or packed, it is valueless if it cannot be identified upon reaching its destination.

ASTM D 996, Standard Terminology of Packaging and Distribution Environments, defined marking as "the applications of numbers, letters, labels, tags, symbols, or colors to provide identification and to expedite handling during shipment and storage".

MARKING STANDARD

The publication that provides the requirements for the uniform marking of military supplies and equipment is Military Standard 129, Marking for Shipment and Storage. This publication is approved for use by all Department and Agencies of the Department of Defense. It accommodates the requirements for coded and in the clear data and the forms required by DOD 4500.25-1-M, Military Standard Requisitioning and Issue Procedures (MILSTRIP); DOD 4000.25-2-M Military Standard Transaction Reporting and Accounting Procedures (MILSTRAP); and DOD 4500.32-R, Military Standard Transaction and Movement Procedures (MILSTAMP).

All required marking and any additional special marking which may be required depending upon the item and container being shipped (fig 1-39) can be found in MIL-STD-129.

ECONOMY IN PACKING

STANDARDIZATION

Economy in packing is the responsibility of everyone concerned with military supply. The Secretary of Defense has established policies on packaging that must be followed. These policies emphasize that the military services standardize their preservation, packaging, and packing. For example, the services, by using packaging standards, assure the same requirements for the same type of items, thus reducing the number of materials, methods, and procedures - whether these requirements are performed by the contractor or by the depot.

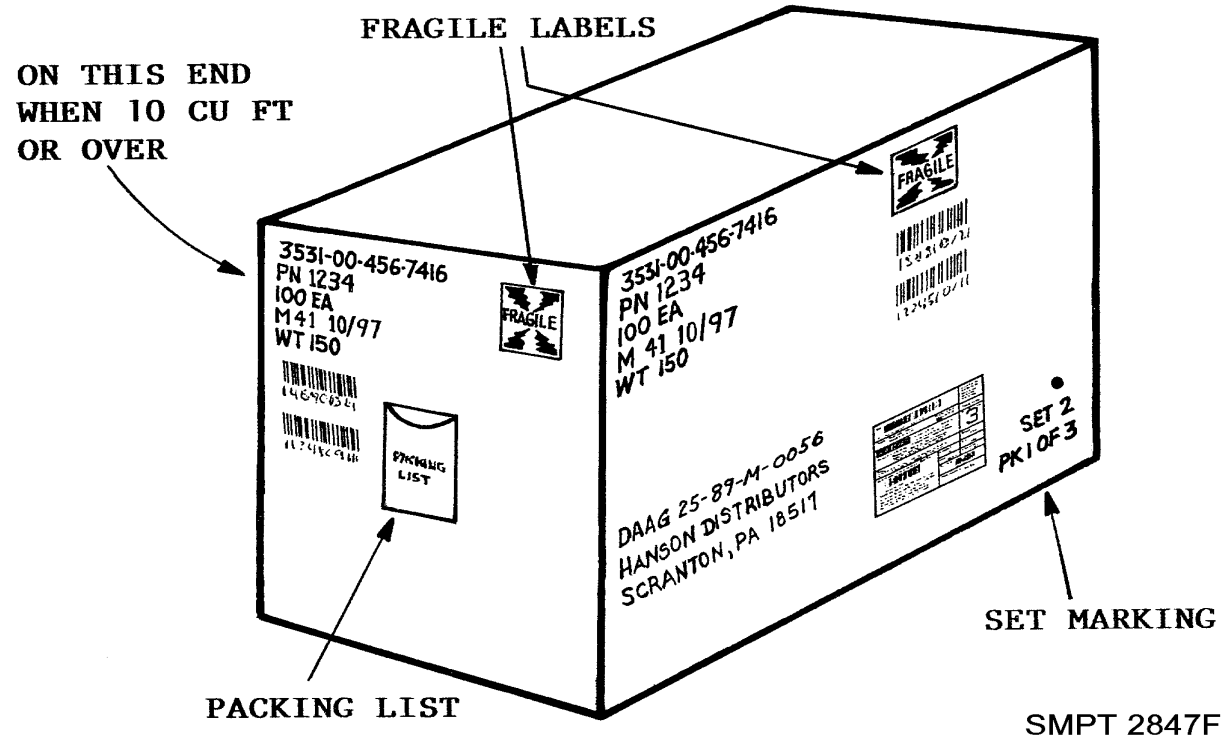

Figure 1-39. Shipping container identification, address, and special markings.

FALSE ECONOMY

Defense material must be protected against all hazards at the lowest possible cost, with the tare weight and cube kept to a minimum. Any attempt, however, to relax standards to anything less than adequate, is false economy. To associate the size and price of an item with the cost of packing is also false economy. Items of small size or low monetary value are often essential to the proper function of a million dollar assembly. To use more material or more expensive material than is essential is also false economy.

REDUCING TARE WEIGHT AND CUBE

One important way to reduce overpacking is through the use of pilot packs carefully engineered and tested for a particular item. The redesigning of established packs and the use of standardized processing forms may result in substantial savings. Wherever the selection of the container is optional, study the comparative initial cost, the labor handling and storage costs, and any possible reduction in tare weight and cube. Probably no area is more fruitful in realizing savings than in the reduction of tare weight and cube.

POTENTIAL AREAS FOR ECONOMY

There are two areas of great saving potential. One is repair parts and general stores items which account for the greatest shipping volume through high turnover. The other is items of large cubic volume on which shipping charges are high, such as pontoons, fuel tanks, electronic equipment, and machine tools. Figure 1-40 shows an example where savings in weight and cube, together with reduction in top heaviness, were achieved by remounting the item on its side. The length of the crate framing members and diagonals was reduced, and the basic strength of the crate was increased by having the angles of the diagonals nearer to the ideal 45 degree.

Figure 1-40. Savings achieved through crating of an item.

Use the most economical container that will adequately handle the load. For example, do not use a Style 2 wooden box having a load limit of 1000 pounds, when a Style 4 box with a load limit of 400 pounds will give all the protection needed. Do not use a wooden box when a lighter container is adequate for the pack.

Develop an active training program for packing supervisors and personnel to alert them to the constant need for the reduction of weight and cube. Figure 1-41 shows how saving in weight, cube, and materials resulted from a simple redesign of the pack.

Make available a greater selection of light weight containers on the packing lines. Operators will not be as likely to use heavier containers when fiberboard or other lightweight containers are available and can do just as well.

Consolidate multipack shipments into low cost containers to eliminate the shipping weight of smaller individual containers. The wood, wirebound, and triple wall fiberboard pallet boxes are all light in weight, are economical and suitable for consolidating materials for domestic and air shipments.

OTHER ECONOMY AREAS

There are several other areas in which economies can be achieved.

MANPOWER

Any reduction in manpower cost will have a definite bearing on the economy of packing. One way to reduce manpower cost is to recognize that the well trained packer is the economical packer. This means using the right man on the right job.

MECHANIZATION

Savings of considerable importance can be derived from the proper use of mechanization. Powerized conveyor belts, mechanized handling systems, and automatic packing machinery, all help to reduce handling and speed up operations.

REUSE OF MATERIALS

Another field in which savings can be effected is through the salvage and reuse of materials. Lumber, cushioning, blocking and bracing materials, containers, and metal fasteners can be reused with a little careful planning (fig 1-42).

Parcel Post

One other area for achieving savings is the more efficient use of parcel post. Frequently, parcel post reduces the need for documentation, allows a lowering of the level of protection, cuts down on marking requirements, and permits faster delivery. Remember, to obtain the maximum value for each Defense dollar, one must be awake to every new idea that may lead to the reduction in packing costs.

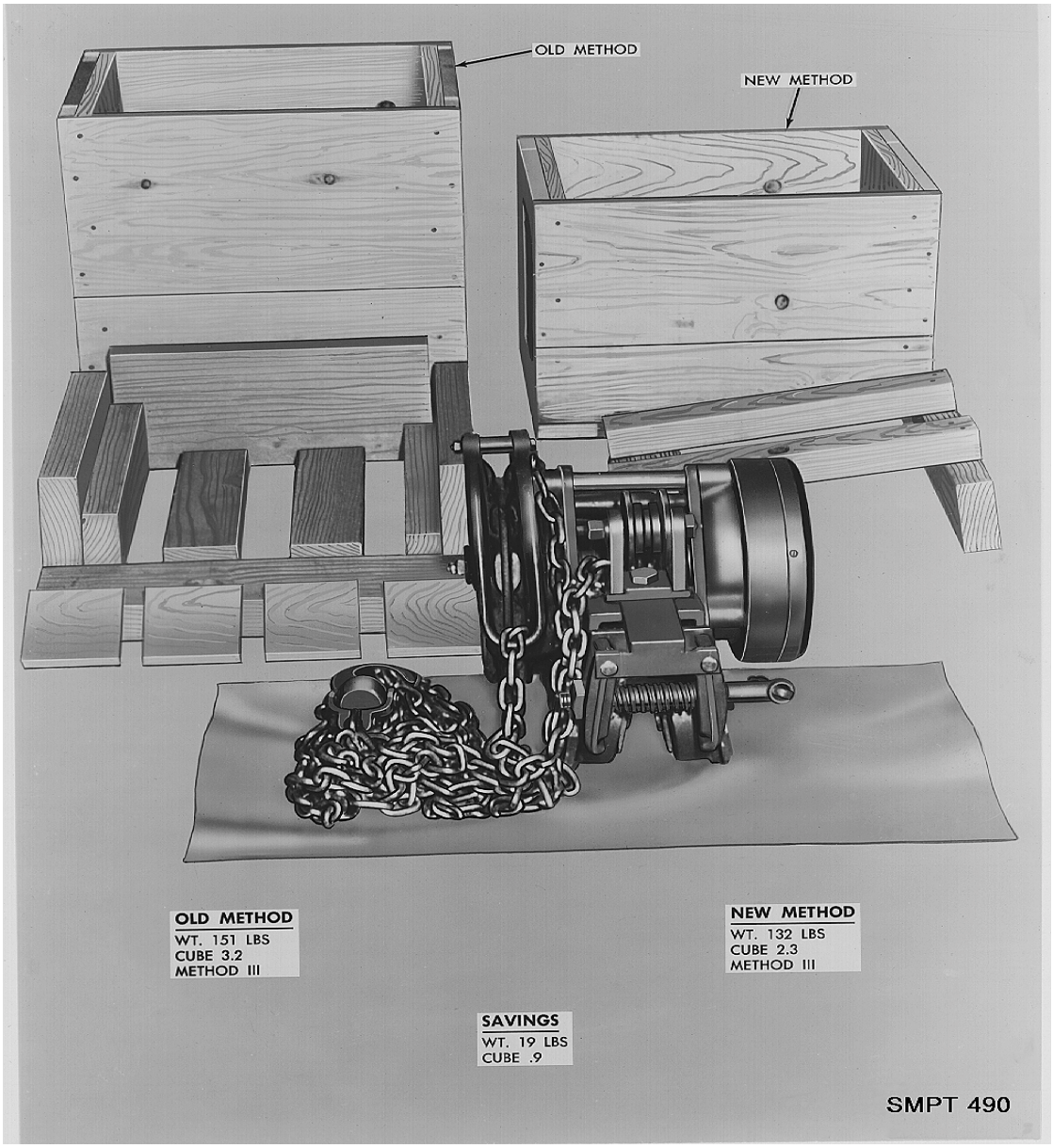

Figure 1-41. Savings achieved by redesigning a container.

PARCEL POST REQUIREMENTS

GENERAL SUPPLIES

Military requirements for parcel post shipments must conform to the Postal Service Manual and the various Armed Service regulations.

Nonmailable Matter

Nonmailable matter includes all matter which is by law, regulation, or treaty stipulation, prohibited from being sent in the mail or which cannot be forwarded to its destination because of illegible, incorrect, or insufficient address.

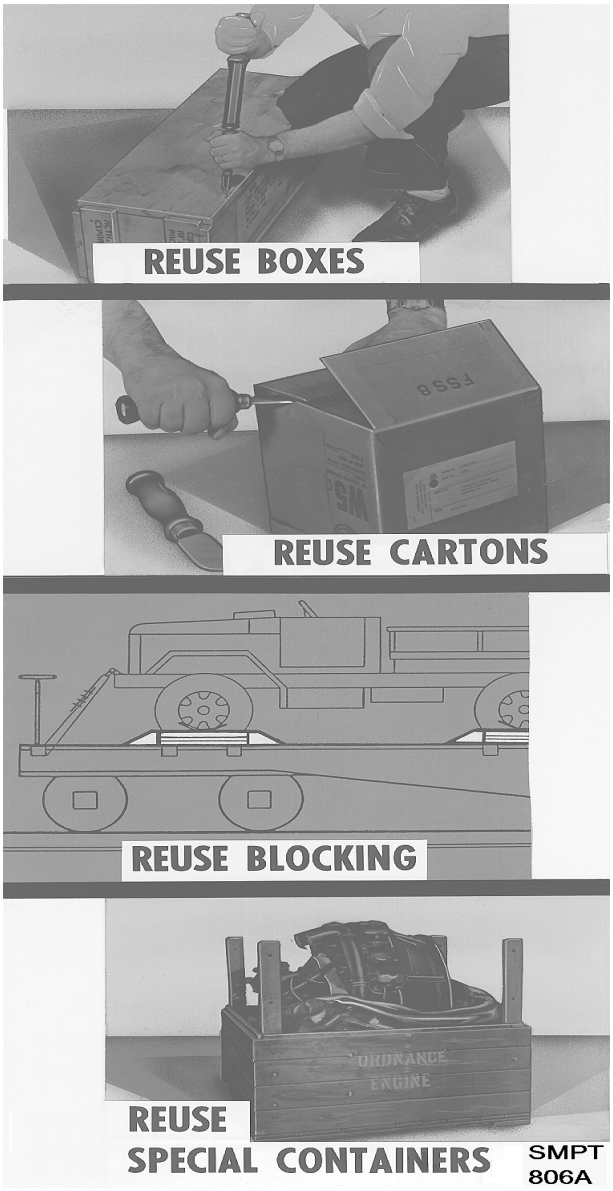

Figure 1-42. Reusing packaging materials means economy.

Harmful Matter

With certain exceptions, any articles, compositions, or materials, which may kill or injure another or injure the mail or other property, are nonmailable. This includes but is not limited to--

- All kinds of poisons, including controlled substances.
- All poisonous animals, except scorpions, all poisonous insects, all poisonous reptiles, and all kinds of snakes, turtles and spiders.
- All disease germs and scabs.
- All explosives, flammable material, internal machines, and mechanical, chemical, or other device or compositions which may ignite or explode.

GENERAL EXAMPLES OF HARMFUL MATTER

Harmful matter includes, among other things, that which is likely to destroy, deface, or otherwise damage the contents of the mailbags or harm the person of anyone engaged in the Postal Service, such as caustic poisons (acids and alkalis), oxidizing materials, or highly flammable solids; or which is likely under conditions incident to transportation to cause fires through friction, through absorption of moisture, through spontaneous chemical changes or as a result of retained heat from manufacturing or processing; explosives or containers previously used for shipping high explosives having a liquid ingredient (such as dynamite), ammunition; fireworks; highly flammable liquids or substances; radioactive materials; matches; or articles emitting a bad odor.

HARMFUL MATTER REQUIREMENTS

Harmful items should not be shipped parcel post without prior approval of the Postal Service. Whenever there is doubt about the mailability of a particular item, a request for a ruling should be made to the local postmaster. Mailability rulings may also be obtained from a nearby mail classification center or from the Office of Mail Classification, US Postal Service, Washington, DC 20260.

TYPES OF SHIPPING CONTAINERS

General

Postal regulations require containers strong enough to retain and protect their contents from the weight of other mail.

Common Containers Used

The following containers, with applicable specification are most commonly used, depending on size, weight, and nature of the article(s): Cotton Mailing Bags (A-A-2714); Burlap Cotton and Waterproof Laminated Textile Shipping Bags (A-A-881); Folding Boxes (PPP-B-566); Fiberboard Boxes (ASTM D5118); Sacks, Shipping, Paper, Cushion (A-A-1588) and Cans, Fiber, Spirally-wound (MIL-C-3955).

Mailbags

Mailbags may be used as containers for consolidated shipments of unbreakable or nonfragile items going to the same location, provided projections are cushioned to prevent rupture of the bag during shipment. Use of one of the three available sizes of mailbag should be based on volume of material going to individual customers.

Used Containers

Used containers in good rigid condition with all flaps intact are acceptable. If a container of desired size cannot be found, a large one may be cut down to meet the needs.

Size and Weight of Container

The shipping containers must be of the proper size to accommodate the item(s) being shipped. Sufficient space for cushioning material should be allowed at the time of container selection, avoiding both the underpacking and overpacking of the item and remaining within the weight limitations. The size and weight of packages mailed at most post offices is limited to 108 inches, length and girth combined, and 70 pounds.

Measurement

Compute the size of a parcel as follows (see Figure 1-43):

- Measure the longest side.
- Measure the distance around the parcel at its thickest part (girth).
- Add both measurements.

Some military post offices overseas have more restrictive size and weight requirements. The weight of an addressed piece of parcel post must be 16 ounces or more.

Reusable Containers

The use of reusable containers may be determined by considering the following factors:

- When the military characteristics of the item are such that a reusable type container is necessary. When the container can serve a dual purpose of shipping container and case while the item is in use. When the item is designated as recoverable-repairable item.
- The cost of a reusable container is offset by multiple use as compared to the cost of single trip, disposable containers.
- When the cost of the item and/or its critical characteristics, or the need for periodic inspection or exercising justifies the use of a reusable container.

Reusable drums with protruding closure devices, such as locking rings, shall be cushioned to prevent injury to postal employees, equipment or other mail.

Outside Wrapping and Closure

When a box itself is an adequate shipping container, paper wraps should be omitted. If a paper wrap is used as an outside cover for boxes, the paper should have at least 60 pounds basis weight. Closure and reinforcement should be made by the use of tape.

Closure and reinforcement is accomplished by using gummed and pressure-sensitive tapes, adhesive, strapping, and staples for boxes and bags. Various friction closures, screw caps and locking devices for cans and similar containers. General purpose transparent mending tape and masking tape shall not be used for closure or reinforcement, but may be used to augment adhesive closure on envelopes or to cover staples on bags. Pressure sensitive filament reinforced tape or reinforced paper tape is recommended for closure and reinforcement. Except for pressure sensitive filament tape, tapes used for closure and reinforcement shall be not less than 2 inches wide.

When strapping is used for closure and reinforcement, it should encircle the length an girth of the package at least once. Twine and cord should not be used. Loose strapping is not acceptable because it presents a hazard to employees and equipment and does not reinforce the container.

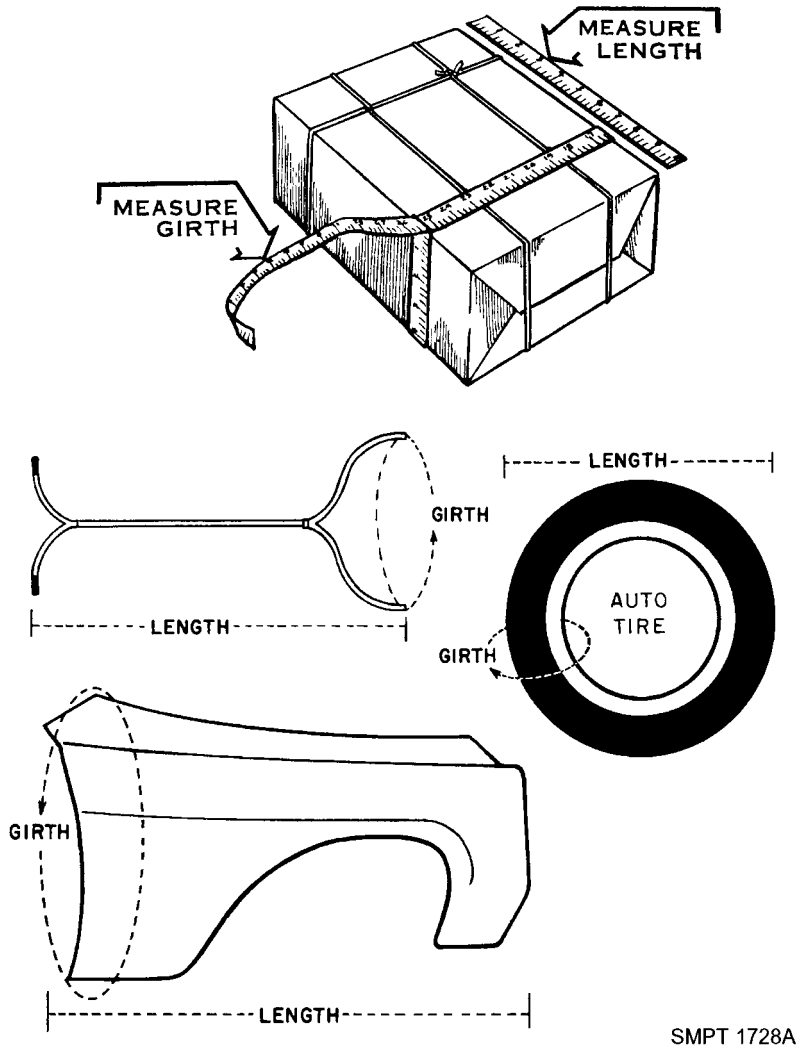

Figure 1-43. Post office measurement requirements.

Marking of Parcels and U.S. Mailbags

Parcels shall be marked to show the consignor; consignee; Transportation Control Number (TCN); and required delivery date, project code, and mark for, when specified.

Marking of U.S. mailbags shipped both domestically and overseas should be tagged in the space located on the locking device to prevent possible opening in transit. Suggested wording of the tag is "OFFICIAL MAIL FOR ORGANIZATION OF ADDRESS. DO NOT OPEN IN TRANSIT."

In addition to the postage tag located on the locking device of the mailing bag, an additional tag will be attached. The tag will notify the local postal authorities that the bag is to be delivered intact to its destination and will contain the complete address to which the bag is destined and the return address.